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TRANSMITTAL LETTER
APPEAL BRIEF

Applicant	:	Hujanen et al.
App. No	:	09/997,396
Filed	:	November 28, 2001
For	:	THIN FILMS FOR MAGNETIC DEVICE
Examiner	:	David Vu
Art Unit	:	2818

CERTIFICATE OF MAILING

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September 14, 2006
(Date)

Andrew N. Merickel, Reg. No. 53,317

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

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Dated: September 14, 2006

Andrew N. Merickel
Registration No. 53,317
Attorney of Record
Customer No. 20,995
(415) 954-4114

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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September 14, 2006
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Andrew N. Merickel, Reg. No. 53,317

ON APPEAL TO THE BOARD OF PATENT APPEALS AND INTERFERENCES

APPEAL BRIEF

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This appeal brief relates to an appeal to the Board of Patent Appeals and Interferences of the Final Rejection set forth in an Office Action mailed on January 18, 2006.

In accordance with the Notice of Appeal filed July 14, 2006, Applicants submit this Appeal Brief.

I. REAL PARTY IN INTEREST

The real party in interest in this Appeal is the Assignee of the application, ASM International N.V.

II. RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any related appeals or interferences.

III. STATUS OF CLAIMS

The present application was originally filed with Claims 1-53 and they remain pending. Claims 33-45 and 51 were withdrawn from consideration as a result of an election by Applicants

in response to a restriction requirement. Claims 1-32, 46-50, 52, and 53 were examined in the present application and were finally rejected in the Office Action dated January 18, 2006. The final rejection was affirmed in an Advisory Action dated April 10, 2006.

Accordingly, Claims 1-32, 46-50 and 52-53 are the subject of this appeal. The pending claims are attached hereto as Appendix A.

IV. STATUS OF AMENDMENTS

The claims before the Board appear as they were finally rejected. The pending claims are attached hereto as Appendix A.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention relates generally to magnetic structures for semiconductor devices and, more particularly, to methods for forming such structures by depositing thin films using atomic layer deposition (ALD). ALD processes (Figure 3) are based on self-saturating surface reactions. The methods disclosed in the present application include atomic layer deposition type processes in which ferromagnetic (12), (16) and dielectric layers (14) are deposited on a substrate to form magnetic structures, such as magnetic memory devices (Fig. 1) and the sensing elements of read heads. Magnetic metal layers (210), (240) are preferably formed by depositing a metal oxide by multiple ALD cycles (200), (230) and then subsequently reducing the metal oxides to elemental metals (210), (240), as illustrated in Figure 6. The formation of elemental layers (210), (240) by depositing a metal oxide (200), (230) and then reducing the metal oxide (210), (240) is beneficial to the formation of magnetic devices. The reduced mobility of the metal atoms in the oxide lowers the probability of island formation in the thin film during deposition and provides for cleaner, more uniform film growth (see, for example, paragraph [0032] of the application as filed).

The appealed claims reflect the disclosed invention. Independent Claim 1 recites a method of fabricating magnetic memory cell comprising providing a substrate on which the magnetic memory cell is formed, depositing a first ferromagnetic layer (12), depositing a dielectric layer (14) over the first ferromagnetic layer (12) and depositing a second ferromagnetic layer (16) over

the dielectric layer (14). At least one of the first or second ferromagnetic layers (12), (16) is formed by depositing a metal oxide by *multiple* ALD cycles (200), (230) and *subsequently* reducing the metal oxide to elemental meta (210), (240).

Support for Claim 1 and the recited process can be found, for example, in paragraphs [0030] through [0032] and Figures 1 and 6 of the specification. Particular support for the claim element "depositing a metal oxide by multiple ALD cycles and subsequently reducing the metal oxide to elemental metal" can be found in paragraph [0032] of the specification.

Independent Claim 14 recites a method of fabricating a magnetic memory cell comprising providing a substrate on which the magnetic memory cell is formed. A first magnetic layer (12) is deposited on the substrate and a dielectric layer (14) is formed over the first magnetic layer (12). A metal oxide layer comprising a magnetic metal is deposited over the dielectric layer(230) by multiple atomic layer deposition cycles and the metal oxide layer is reduced (240) to a magnetic elemental metal layer (16). Again, support for this claim can be found in paragraphs [0029] through [0032] of the specification and Figures 1 and 6.

Independent Claim 15 recites a method of fabricating a magnetic memory cell in which a first magnetic layer (12) is formed on a substrate and a first nonmagnetic metal oxide layer is deposited over the first magnetic layer. The first nonmagnetic metal oxide layer is converted to a first nonmagnetic metal layer (13) and an insulating layer (14) is deposited on the first nonmagnetic metal layer (13). A second nonmagnetic metal oxide layer is deposited by multiple ALD cycles and subsequently converted to a second nonmagnetic metal layer (15). A second magnetic layer (16) is deposited on the second nonmagnetic metal layer (15). Support for this claim can be found, for example, in Figure 2, paragraphs [0023] through [0032], Figure 2 and Examples 1-4.

Independent Claim 20 recites a method of fabricating a magnetic nanolaminate structure comprising depositing a plurality of metal oxide layers (100), (110), (120) on a substrate by multiple ALD cycles (Fig. 3), wherein at least two of the metal oxide layers (100), (110), (120) differ in composition. At least one of the plurality of metal oxide layers is subsequently converted to an elemental layer (130) and at least one of the metal oxide and elemental metal

layers is magnetic. Support for Claim 20 can be found, for example, in Figure 5, and paragraphs [0032], [0037] through [0043] and [0052] through [0055].

Independent Claim 46 recites a method of fabricating a sensing element of a read head comprising providing a substrate on which the sensing element is to be formed. A first ferromagnetic layer (34) is deposited by ALD, a conductive layer (36) is deposited over the first ferromagnetic layer (34), and a second ferromagnetic (38) layer is deposited over the conductive layer (36). Support can be found, for example, in paragraphs [0047] through [0051] of the specification and Figure 4.

Finally, independent Claim 52 recites a method of fabricating magnetic memory cell in which a first ferromagnetic layer (12) is deposited, a dielectric layer (14) is deposited over the first ferromagnetic layer (12) and a second ferromagnetic layer (16) is deposited over the dielectric layer (14). At least one of the first (12) or second (16) ferromagnetic layers is deposited by depositing a metal oxide by ALD cycles (200), (230) and subsequently reducing the metal oxide to elemental metal (210), (240). Support can be found, for example, in paragraphs [0030] through [0032] and Figures 1 and 6 of the specification.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

This Appeal turns on whether Claims 1-32, 46-50 and 52-53 are improperly rejected under 35 U.S.C. § 102(e) as being anticipated by Gates et al. (U.S. Patent No. 6,203,613).

VII. APPELLANT'S ARGUMENT

In the Final Office Action mailed on January 18, 2006, the Examiner finally rejected Claims 1-32, 46-50 and 52-53 under 35 U.S.C. § 102(e) as being anticipated by Gates et al. (U.S. Patent No. 6,203,613, hereinafter "Gates"). The Examiner found that in Example 8, Gates discloses depositing a first ferromagnetic layer, a dielectric layer and a second ferromagnetic layer by atomic layer deposition. Further, the Examiner stated that "the precursors $M(NO_3)_x$ was [sic] formed by ALD and subsequently using hydrogen reduction [sic] to selectively deposit multilayer metal films onto substrates." Thus, the Examiner appears to have taken the position that the adsorption of a metal precursor containing oxygen and its subsequent reduction is equivalent to

deposition of a metal oxide by ALD and reducing the actual oxide to elemental metal. Applicants disagree and submit that adsorption of a metal nitrate precursor is *not* equivalent to deposition of a metal oxide by ALD.

As is well known in the art and described in the specification, for example at paragraphs [0056] through [0057] and illustrated in Figure 3, ALD is a process where the deposition of a thin film onto a substrate is based on sequential and alternating self-saturating surface reactions using at least *two* separate vapor phase source chemicals. Thus, the Examiner's assertion that "the precursors $M(NO_3)_x$) was [sic] formed by ALD" is simply not correct. The metal nitrate precursor in Gates was provided to the substrate as a single metal nitrate source chemical *as part of an ALD process*. The metal nitrate was not formed by ALD because it was not formed on the substrate from alternating and sequential self-saturating surface reactions of at least two separate vapor phase source chemicals. The only time the source chemical existed on the substrate was when the ALD cycle was incomplete. Because the adsorption of a single source chemical is not deposition of the chemical by ALD, and Gates has no other possible teaching of depositing a metal oxide by ALD, the Gates reference can not be considered to teach or suggest deposition of a metal oxide by ALD followed by the subsequent reduction of "the" metal oxide so deposited and can not anticipate Claims 1, 14, 15, 20 and 52.

Nevertheless, even if the Examiner's argument that adsorption of a metal nitrate precursor is equivalent to deposition of a metal oxide by ALD is accepted, Gates still does not anticipate independent Claims 1, 14, 15, 20 and 52 because it only teaches reduction within *each* ALD cycle. Claim 46 is not anticipated because Gates does not teach or suggest depositing the recited layers in the recited order.

Independent Claims 1, 14, 15, 20, and 52 clearly indicate that a metal oxide is formed by *multiple* ALD cycles. That is, in each ALD cycle metal oxide is deposited but *not reduced* and the ALD cycles are repeated until an oxide of the desired thickness has been deposited. Because metal oxide is deposited (but not reduced) in multiple cycles, this results in a metal oxide layer with a thickness that is greater than a single layer of adsorbed reactant. According to the claims, "the" metal oxide layer so formed is reduced *after* the multiple ALD cycles are complete, as

clearly indicated in the claims. Thus, reduction does not occur in each ALD cycle, *but only after multiple ALD cycles*. This is very different from a situation in which an oxygen-containing metal reactant is adsorbed *and* reduced in *each* of a number of ALD cycles, as in Example 8 in Gates pointed to by the Examiner in support of the rejection.

The Examiner also referred to column 4, lines 40-51 of Gates for teaching the deposition of a ferromagnetic layer by depositing a metal oxide by ALD and subsequently reducing the metal oxide to elemental metal. However, while this section of Gates refers to reactants generally there is simply no teaching of depositing a metal oxide layer and subsequently reducing it to elemental metal.

In response to Applicants' previous arguments, the Examiner stated that "Gates clearly discloses depositing a metal oxide layer (Col. 11, l. 36; step 3 of the ALD cycle (iron nitrate)) by 200 ALD cycles (Col. 11, ll. 44-45) by reduction of the metal oxide (Col. 11, ll. 38-39); steps 4 and 5 of the ALD cycle (inert purge-hydrogen))." The Examiner concluded that Gates clearly discloses all of the features of the claims. Applicants strongly disagree. Rather, this section of Gates discloses a process in which an oxygen-containing metal precursor is reduced to metal *in each ALD cycle*. While iron nitrate is adsorbed on the substrate *in each ALD cycle*, there is no deposition of a *metal oxide by multiple ALD cycles* and subsequent reduction of *"the" so formed metal oxide* as claimed.

To anticipate a claim, a reference must have each and every element of the claim. *See*, for example, M.P.E.P.. § 2131. Each of the sections of Gates pointed to by the Examiner is specifically discussed below.

First, the Examiner referred to Col. 11, line 36 (step 3 of a disclosed ALD cycle) for the deposition of a metal oxide layer. Applicants note that this line refers to a single pulse of iron nitrate precursor *within* an ALD cycle. It does not refer to a complete ALD cycle for depositing iron nitrate. In particular, line 36 referred to by the Examiner teaches the provision of the iron nitrate precursor to the reaction chamber for 0.5 seconds. Thus, no identifiable metal oxide is formed by *multiple ALD cycles* in this step. Rather, a single layer of iron nitrate is adsorbed as part of a *single* ALD cycle.

The Examiner next referred to 200 ALD cycles in Col. 11, ll. 44-45. This section of the Gates reference refers to the deposition of an iron manganese (FeMn) alloy and *not* to the deposition of iron nitrate or a metal oxide. This is quite clear from the sentence referred to by the Examiner which states "the desired thickness of the *FeMn alloy* was 10 nm, thus 200 cycles were used." Again, this does not teach or suggest depositing *metal oxide by multiple ALD cycles*.

The Examiner then referred back to Col. 11, ll. 38-39, steps 4 and 5 for teaching of reduction of the metal oxide. These steps actually refer to an inert purge and a hydrogen pulse for reducing the adsorbed metal nitrate *within a single ALD cycle*. That is, in this example in Gates a single pulse of iron nitrate is allowed to adsorb to the substrate and is subsequently reduced *in each cycle*. The 200 ALD cycles referred to by the Examiner are, again, directed to the entire ALD process for depositing iron manganese alloy. At the end of each of the individual ALD cycles, iron manganese alloy is formed, not a metal oxide. This does not teach or suggest depositing *a metal oxide layer by multiple ALD cycles*, followed by reduction of *"the"* metal oxide layer as claimed.

In summary, the Examiner has suggested that iron nitrate is deposited by 200 ALD cycles and subsequently reduced. This is not what is taught or suggested in Gates. To the contrary, iron nitrate is reduced in *each* of 200 ALD cycles in the process disclosed in Gates. While there might be a final reduction step, it does not reduce the product of several hundred cycles, but only the metal nitrate of *one* cycle. Thus, Gates does not teach or suggest first depositing a metal oxide layer by repeating an ALD cycle multiple times (without reduction of metal oxide) and then reducing that deposited metal oxide layer to elemental metal.

Each of the independent claims and their respective dependent claims are addressed with particularity below.

First, Claim 1 clearly indicates that at least one of the first or second ferromagnetic layers is formed by depositing a metal oxide by *multiple* ALD cycles and *subsequently* reducing *the* metal oxide to elemental metal. In contrast, in the Gates reference metals are deposited by contacting a substrate with a metal nitrate precursor and reducing the metal nitrate to elemental metal *in each ALD cycle*. Gates does not teach or suggest depositing a metal oxide by multiple

ALD cycles, to say nothing of forming a metal oxide by multiple cycles and then reducing the metal oxide to elemental metal as claimed. As mentioned above, in Example 8 of Gates referred to by the Examiner, ferromagnetic layers are made by reacting manganese and iron nitrate with iron and by reacting cobalt nitrate with hydrogen.

As there is no teaching or suggestion in Gates of forming a ferromagnetic layer by depositing a metal oxide by *multiple* ALD cycles and *subsequently* reducing the metal oxide to elemental metal, Applicants submit that the rejection of Claim 1 should be withdrawn. In addition, as Claims 2-13 depend from Claim 1 and contain all of the features thereof in addition to further distinguishing features, the rejection of these claims should be withdrawn as well.

Similarly, with regard to Claim 14, the Examiner found that Gates teaches depositing a magnetic metal oxide layer over a dielectric layer by atomic layer deposition and reducing the magnetic metal oxide layer to a magnetic elemental metal layer. The Examiner referred to Col. 11, lines 55-65 and Col. 4, lines 40-51 for this teaching. Again, Applicants submit that Gates teaches reducing a metal nitrate precursor *in every ALD cycle*. That is, in each ALD cycle, Gates reduces any adsorbed oxygen-containing metal precursor to metal. Gates does not teach or suggest depositing a magnetic metal oxide layer over the dielectric by multiple atomic layer deposition cycles, much less deposition followed by reduction of the metal oxide layer to a magnetic elemental layer as recited in Claim 14.

With respect to Claim 15-19, the Examiner referred to disclosure in Gates at column 3, lines 63-67 which states that the invention provides an ALD process to form a structure which contains "alternating films of metal oxides, metal nitrides and metals in any combination." The Examiner simply stated that the claimed method would be "inherent in the product and process of the prior art."

Applicants respectfully submit that the sections of Gates referred to by the Examiner simply recite reactants and film types. There is no teaching or suggestion of any particular arrangement of films that would form a magnetic memory cell, much less of a method of fabricating a magnetic memory cell as claimed. As clearly stated in MPEP §2131, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or

inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). In addition, the elements must be arranged as required by the claim. *In re Bond*, 910 F.2d 831, 15 USPQ2d 1566 (Fed. Cir. 1990).

Here, Gates does not teach each element of Claim 15 or the arrangement of the elements. For example, Gates does not teach or suggest depositing a first non-magnetic metal oxide layer over the first magnetic layer and converting the first non-magnetic meal oxide layer to a first non-magnetic metal layer as recited in Claim 15. Gates also does not teach or suggest a particular structure that would inherently disclose the claimed method.

Claim 15 also clearly indicates that the second nonmagnetic metal oxide layer is deposited by ***multiple*** ALD deposition cycles ***prior*** to being converted to a second nonmagnetic metal layer. Again, Gates only teaches reduction of a metal nitrate precursor ***in each ALD cycle*** and does not teach or suggest depositing a metal oxide layer by multiple atomic layer deposition cycles, much less subsequently converting such a metal oxide layer to a metal layer. Thus, Applicants submit that the rejection of Claims 14 and 15 should be withdrawn, along with the rejection of Claims 16-19 which depend from Claim 15.

The Examiner rejected independent Claim 20, finding that Gates discloses a method of fabricating a magnetic structure comprising depositing a plurality of metal oxide layers by ALD and converting at least one of the metal oxide layers to elemental metal. The Examiner referred again to Example 8, Col. 11, lines 24-65. Claim 20 recites depositing a plurality of metal oxide layers on a substrate by ***multiple atomic layer deposition cycles*** and ***subsequently*** converting at least one of the ***plurality*** of metal oxide layers to an elemental metal layer. As discussed above, Gates has no teaching or suggestion in Example 8 or anywhere else for that matter, of depositing ***a plurality*** of metal oxide layers by ***multiple*** ALD cycles and ***subsequently*** converting at least one of the metal oxide layers to elemental metal. As a result, Applicants submit that the rejection of Claim 20 and Claims 21-32, which depend from Claim 20, should be withdrawn.

With respect to Claim 46, the Examiner asserted that as used in Gates, the term "metal-containing films" includes metal oxides, metal nitrides, elemental or any combination or mixture

thereof, including multilayers and multicomponent films. The Examiner concluded that the disclosure in Gates that structures can comprise alternating oxides, nitrides and metal films "in any combination" inherently anticipates the specific method recited in Claim 46. However, for a prior art reference to anticipate a claim, each and every element of the claim must be present in a single reference and the elements must be arranged as they are in the claim. *In re* Bond, 910 F. 2d 8931, 15 USPQ.2d 1566, 1567 (Fed. Cir. 1990). Applicants respectfully submit that the recitation of "any combination or mixture thereof including multilayer and multicomponent films" does not teach or suggest any particular structure, much less inherently teach or suggest a method of fabricating a sensing element of a read-head comprising depositing a first ferromagnetic layer by ALD, depositing a conductive layer over the first ferromagnetic layer and depositing a second ferromagnetic layer over the conductive layer as claimed. As neither the method nor a structure that would inherently teach or suggest the method are taught anywhere in Gates, Applicants submit that the rejection of Claims 46-50 should be withdrawn.

With respect to Claim 52, the Examiner again found that Gates teaches or suggests, in Example 8, depositing a ferromagnetic metal oxide layer over a dielectric layer by ALD and reducing the magnetic metal oxide layer to magnetic element metal layer. Claim 52 clearly indicates that depositing at least one of the first or second ferromagnetic layers comprises depositing a metal oxide by *multiple* ALD cycles and *subsequently* reducing the metal oxide to elemental metal. Once more, Applicants submit that Gates et al. only teaches reducing a metal nitrate precursor *in each ALD cycle*. There is no teaching or suggestion of depositing a metal oxide by *multiple* ALD cycles and *subsequently* reducing the metal oxide to elemental metal. Thus, the rejection of Claims 52 and Claim 53, which depends therefrom, should be withdrawn.

VIII. CONCLUSIONS

Applicants submit that the cited Gates reference does not anticipate the pending claims. The Examiner has ignored the recitation of the claims indicating that a metal oxide is formed by *multiple* ALD cycles and *subsequently* reduced and/or the recitation of deposition of particular films in a particular order. Hence, because anticipation has not been established, Applicants

request that the rejection under 35 U.S.C. § 102 be removed and that claims 1-32, 46-50, 52, and 53 be allowed.

IX. APPENDIX A – Claims Appendix

Attached hereto as Appendix A is a copy of the claims that are the subject of the present appeal.

X. APPENDIX B – Evidence Appendix

Attached hereto as Appendix B is a copy of Gates et al. (U.S. Patent No. 6,203,613).

XI. APPENDIX C – Related Proceedings Appendix

Appellants are unaware of any related proceedings.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Andrew N. Merickel
Registration No. 53,317
Attorney of Record
Customer No. 20,995
(415) 954-4114

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APPENDIX A

1. (Previously Presented) A method of fabricating a magnetic memory cell, comprising:

providing a substrate on which the magnetic memory cell is formed;

depositing a first ferromagnetic layer;

depositing a dielectric layer over the first ferromagnetic layer; and

depositing a second ferromagnetic layer over the dielectric layer, wherein depositing at least one of the first or second ferromagnetic layers comprises depositing a metal oxide by multiple ALD cycles and subsequently reducing the metal oxide to elemental metal.

2. (Original) The method of Claim 1, wherein the magnetic memory cell comprises a magnetic tunneling junction (MTJ).

3. (Original) The method of Claim 1, wherein the magnetic memory cell is a magnetic random access memory cell.

4. (Original) The method of Claim 1, wherein the dielectric layer is deposited by ALD.

5. (Original) The method of Claim 1, wherein the dielectric layer comprises aluminum oxide.

6. (Original) The method of Claim 1, wherein the first ferromagnetic layer is deposited by ALD.

7. (Original) The method of Claim 6, wherein depositing the first ferromagnetic layer by ALD comprises depositing a metal oxide by ALD and subsequently reducing the metal oxide to elemental metal.

8. (Previously Presented) The method of Claim 7, wherein the elemental metal comprises cobalt.

9. (Original) The method of Claim 1, wherein depositing the second ferromagnetic layer comprises an ALD process.

10. (Original) The method of Claim 9, wherein depositing the second ferromagnetic layer comprises depositing a metal oxide by ALD and subsequently reducing the metal oxide to elemental metal.

11. (Original) The method of Claim 10, wherein the elemental metal comprises cobalt.

12. (Original) The method of Claim 1, wherein the first ferromagnetic layer has a lower magnetic permeability than the second ferromagnetic layer.

13. (Original) The method of Claim 1, wherein the first ferromagnetic layer is thinner than the second ferromagnetic layer.

14. (Previously Presented) A method of fabricating a magnetic memory cell, comprising:

providing a substrate on which the magnetic memory cell is formed;

depositing a first magnetic layer on the substrate;

forming a dielectric layer over the first magnetic layer;

depositing a metal oxide layer comprising a magnetic metal over the dielectric layer by multiple atomic layer deposition (ALD) cycles; and

reducing the metal oxide layer to a magnetic elemental metal layer.

15. (Previously Presented) A method of fabricating a magnetic memory cell, comprising:

providing a substrate on which the magnetic memory cell is formed;

forming a first magnetic layer on the substrate;

depositing a first non-magnetic metal oxide layer over the first magnetic layer;

converting the first non-magnetic metal oxide layer to a first non-magnetic metal layer;

depositing an insulating layer on the first non-magnetic metal layer;

depositing a second non-magnetic metal oxide layer by multiple atomic layer deposition (ALD) cycles;

converting the second non-magnetic metal oxide layer to a second non-magnetic metal layer; and

depositing a second magnetic layer on the second non-magnetic metal layer.

16. (Original) The method of Claim 15, wherein the first non-magnetic metal oxide layer is deposited by ALD.

17. (Original) The method of Claim 15, wherein the first non-magnetic metal oxide layer and the second non-magnetic metal oxide layer are converted to the first and second non-magnetic metal layers by reducing the metal oxide to elemental metal.

18. (Original) The method of Claim 17, wherein reducing comprises exposing the metal oxide layer to a chemical selected from the group consisting of hydrogen, hydrogen-rich radicals, carbon monoxide, alcohol vapor, aldehyde vapor and carboxylic acid vapor.

19. (Original) The method of Claim 15, wherein the first and the second non-magnetic metal oxide layers comprise copper oxide.

20. (Previously Presented) A method of fabricating a magnetic nanolaminate structure, comprising:

depositing a plurality of metal oxide layers on a substrate by multiple atomic layer deposition (ALD) cycles, wherein at least two of the metal oxide layers differ in composition; and

subsequently converting at least one of the plurality of metal oxide layers to an elemental metal layer, wherein at least one of the metal oxide and elemental metal layers is magnetic.

21. (Original) The method of Claim 20, wherein the magnetic nanolaminate structure is part of a magnetic memory device.

22. (Original) The method of Claim 20, wherein the magnetic nanolaminate structure is part of a read-head.

23. (Original) The method of Claim 20, wherein the magnetic nanolaminate structure comprises a magnetic tunneling junction.

24. (Original) The method of Claim 20, wherein the magnetic nanolaminate structure is part of a spin valve transistor.

25. (Previously Presented) The method of Claim 20, wherein depositing the plurality of metal oxide layers comprises, in order: depositing a first metal oxide layer, depositing an insulating layer, and depositing a second metal oxide layer, wherein each of the first and second metal oxide layers either comprises a magnetic metal or is a magnetic oxide.

26. (Previously Presented) The method of Claim 20, wherein depositing the plurality of metal oxide layers comprises, in order: depositing a first metal oxide layer, depositing a first non-magnetic metal oxide layer, depositing an insulating layer, depositing a second non-magnetic metal oxide layer, and depositing a second metal oxide layer, wherein each of the first and second metal oxide layers either comprises a magnetic metal or is a magnetic oxide.

27. (Original) The method of Claim 20, wherein converting comprises reducing a metal oxide layer to elemental metal.

28. (Original) The method of Claim 27, wherein reducing comprises contacting the layer with a compound selected from the group consisting of hydrogen, hydrogen-rich radicals, carbon monoxide, alcohol vapor, aldehyde vapor and carboxylic acid vapor.

29. (Original) The method of Claim 20, wherein at least one of the metal oxide layers comprises a ferromagnetic oxide selected from the group consisting of magnetite (Fe_3O_4), CrO_2, manganite perovskites doped with alkaline earth metals and metal oxide superlattices.

30. (Original) The method of Claim 20, wherein the magnetic nanolaminate comprises at least one magnetic metal selected from the group consisting of iron (Fe), cobalt (Co) and nickel (Ni).

31. (Original) The method of Claim 20, wherein the magnetic nanolaminate comprises at least one non-magnetic metal.

32. (Original) The method of Claim 31, wherein the non-magnetic metal is copper.

33. (Withdrawn) A method of depositing a metal layer for a magnetic device by atomic layer deposition (ALD), wherein the ALD process comprises alternately contacting a substrate with volatile metal source chemicals and hydrogen-rich plasma.

34. (Withdrawn) The method of Claim 33, wherein the ALD process forms a metal oxide.

35. (Withdrawn) The method of Claim 34, further comprising reducing the metal oxide.

36. (Withdrawn) The method of Claim 34, wherein the metal oxide comprises a magnetic metal.

37. (Withdrawn) The method of Claim 36, wherein the magnetic metal is selected from the group consisting of iron (Fe), cobalt (Co) and nickel (Ni).

38. (Withdrawn) The method of Claim 34, wherein the metal oxide comprises a non-magnetic metal.

39. (Withdrawn) The method of Claim 33, wherein the magnetic device comprises an integrated MRAM magnetic tunnel junction.

40. (Withdrawn) The method of Claim 33, wherein the magnetic device comprises a spin valve transistor.

41. (Withdrawn) The method of Claim 33, wherein, the magnetic device comprises a pseudo spin valve.

42. (Withdrawn) A method of manufacturing a magnetic element in an integrated circuit, comprising:

providing a substrate comprising a hard magnetic material;

cleaning the substrate surface;

depositing an aluminum oxide tunneling dielectric by atomic layer deposition (ALD) on the substrate;

depositing cobalt oxide over the aluminum oxide by ALD; and

reducing the cobalt oxide to cobalt metal.

43. (Withdrawn) The method of Claim 42, wherein cleaning comprises sputter-etching.

44. (Withdrawn) The method of Claim 42, wherein cleaning comprises contacting the substrate surface with a gas selected from the group consisting of hydrogen, hydrogen-rich radicals, carbon monoxide, alcohol vapor, aldehyde vapor and carboxylic acid vapor.

45. (Withdrawn) The method of Claim 42, wherein reducing the cobalt oxide comprises contacting the substrate with a gas selected from the group consisting of hydrogen, hydrogen-rich radicals, carbon monoxide, alcohol vapor, aldehyde vapor and carboxylic acid vapor.

46. (Original) A method of fabricating a sensing element of a read-head comprising:

providing a substrate on which the sensing element is to be formed;

depositing a first ferromagnetic layer by atomic layer deposition (ALD);

depositing a conductive layer over the first ferromagnetic layer; and

depositing a second ferromagnetic layer over the conductive layer.

47. (Original) The method of Claim 46, wherein the conductive layer is deposited by atomic layer deposition.

48. (Original) The method of Claim 46, wherein the second ferromagnetic layer is deposited by atomic layer deposition.

49. (Original) The method of Claim 46, wherein the first ferromagnetic layer comprises NiFe and the second ferromagnetic layer comprises Co.

50. (Original) The method of Claim 46, wherein the conductive layer comprises Cu.

51. (Cancelled)

52. (Previously Presented) A method of fabricating a magnetic memory cell, comprising:

providing a substrate on which the magnetic memory cell is formed;

depositing a first ferromagnetic layer;

depositing a dielectric layer over the first ferromagnetic layer; and

depositing a second ferromagnetic layer over the dielectric layer, wherein depositing at least one of the first or second ferromagnetic layers comprises depositing a

metal oxide by multiple ALD cycles and subsequently reducing the metal oxide to elemental metal.

53. (Previously Presented) The method of Claim 52, wherein the elemental metal comprises cobalt.

APPENDIX B – Evidence Appendix

Copy of U.S. Patent No. 6,203,613 to Gates et al.

APPENDIX C – Related Proceedings Appendix

Appellants are unaware of any related proceedings.